Finally, it should be noted that with the description of the quite distinct *Cymophora hintonii* (above) the genus now has three well-marked species (Fig. 3–5), and presumably additional taxa will be uncovered as this poorly known region of Mexico in which they occur becomes better known.

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A COMPARISON OF EPILOBIUM MINUTUM AND E. FOLIOSUM (ONAGRACEAE)

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All but six of the approximately 200 species comprised in the genus *Epilobium* have a gametic chromosome number of $n = 18$, with some polyploidy in sect. *Chamaenerion* Tausch. Among the unusual species, *E. minutum* Lindl. ex Lehm. (Fig. 1A) has $n = 13$ (Kurabayashi et al., 1962; Taylor and Mulligan, 1968), and what has generally been regarded as a trivial form or variety of it, *E. foliosum* (T. & G.) Suksd. (Fig. 1B), has $n = 16$. These two closely related species together compose one of the sections of the genus, sect. *Crossostigma* (Spach) Raven (Raven, 1976). The purpose of this paper is to present the cytological and morphological evidence that distinguishes them and to outline their respective distributions in western North America. They were treated in a preliminary fashion, on the basis of information we provided, by Munz (1965, p. 208–9).

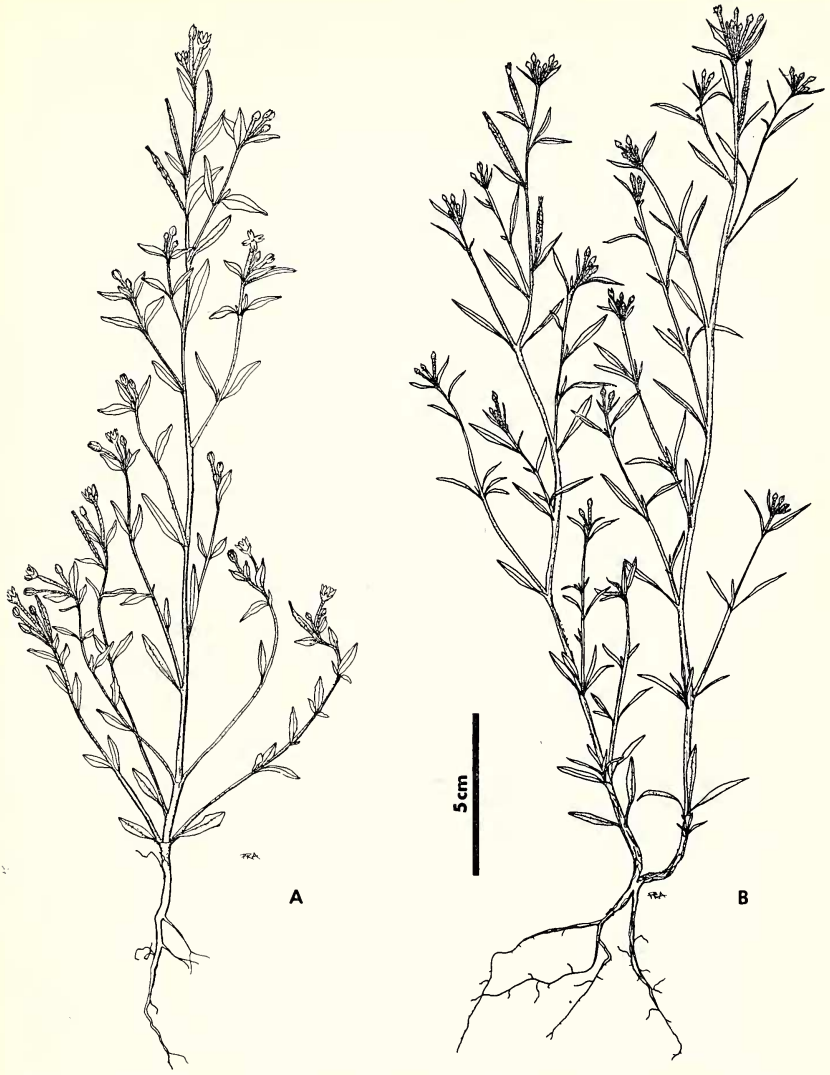

FIG. 1. The 2 species of *Epilobium* sect. *Crossostigma*. A, *E. minutum*. B, *E. foliosum*.

Both *Epilobium minutum* and *E. foliosum* are annuals, a habit they share with only one other species in the genus, *E. paniculatum* Nutt. ex T. & G. Unlike most of the other members of the genus, these three species are found in xeric habitats. We do not believe that there is a direct relationship between the spring-blooming sect. *Crossostigma,* considered here, and the summer-blooming *Epilobium paniculatum*. Consequently, we hypothesized that the annual habit has been derived independently in each line (Raven, 1976).

It is difficult to suggest a hypothesis for the derivation of the unique chromosome numbers of *Epilobium minutum* ($n = 13$) and *E. foliosum* ($n = 16$). In view of the absence of intermediate chromosome numbers, however, we believe that they are most likely derived independently from presumably extinct diploid ancestors with $n = 8$, 7, and 6 (Stebbins, 1971, p. 193).

Both *Epilobium minutum* and *E. foliosum* are highly autogamous, with *E. foliosum* often actually cleistogamous; as a result of this, many highly inbred morphologically distinguishable lines are apparent in both species. Several morphological characters, however, consistently distinguish the two species. The flowers of *E. minutum* are larger than those of *E. foliosum* (the petals up to 5 mm long), and the buds are broadly ovoid, often nodding, and borne in relatively uncrowded inflorescences. The narrowly elliptic cauline leaves are subacute at the apex and flat or nearly so. *Epilobium foliosum,* on the other hand, has erect, narrowly ovoid buds in a crowded inflorescence. The flowers are often cleistogamous and the petals rarely exceed 2 mm in length. The narrowly elliptic leaves are acuminate and often folded along the midrib. Axillary fascicles of leaves are more common than in *E. minutum*.

Additional differences between these two species include seed size and seed coat architecture. The seeds of *E. foliosum* are smaller, 0.64–0.85 mm long, and very slightly papillose when viewed with a dissecting microscope ($\times$ 20). When viewed with the scanning electron microscope, the seed coat is seen to be composed of a series of smooth raised areas, one over each cell lumen, with these raised areas separated by a reticulate network of minutely papillose side walls (Fig. 2, D–F). The larger seeds of *E. minutum,* 0.86–1.20 mm long, are smooth when viewed with a dissecting microscope and generally minutely papillose with a depressed area over each cell lumen when viewed with the scanning electron microscope (Fig. 2, A–C). Both of these seed coat types apparently are confined to sect. *Crossostigma* and unique to the respective species.

The distributions of these two species are similar (Fig. 3). Not only do they overlap geographically, but they are also often found growing sympatrically; a number of collections we examined included both species. *Epilobium minutum* is the more common northward, whereas *E. foliosum* is more frequent in the south. The prevalent autogamy of both species, coupled with their small, tufted seeds, makes them excellent colonizers, and they are often found in disturbed areas such as roadcuts and recently burned areas.

Epilobium foliosum has been found in California as far south as Los Angeles Co., and has been collected at least twice in Arizona (Gila Co., *Peebles & Smith 13273,* ARIZ, CAS, POM, US; Pinal Co., *Nelson 1905,* ARIZ, GH, NY, UC, US). Its northward distribution follows the coastal foothills from Ventura Co., California, through Oregon and Washington

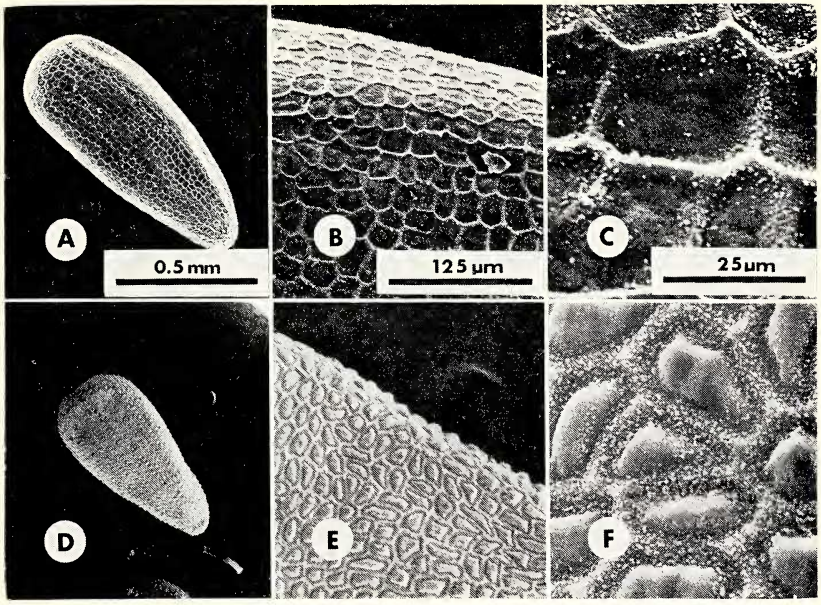

FIG. 2. Scanning electron micrographs of seeds. A–C, *Epilobium minutum;* D–F, *E. foliosum.*

into British Columbia, with northeastern limits in Idaho and northern limits on Vancouver Island, British Columbia (*Taylor 46108,* UC). The species is also scattered in the foothills of the Sierra Nevada of California, where it has been collected as far south as Tulare Co.

Epilobium minutum is less frequent in southern California, but ranges through the coastal foothills from Santa Barbara Co., California, to British Columbia. It is scattered in the Sierra foothills from Mariposa Co., California, northward and, like *E. foliosum,* is relatively poorly represented in this part of its range. The northern distribution of this species is more extensive than that of *E. foliosum,* and it reaches Stuie (40 mi E of Bella Coola), British Columbia (52° N, *McCabe 1546,* UC), and the Queen Charlotte Islands at nearly 54° N (Calder and Taylor, 1968, p. 438). The northeastern limits of *E. minutum* are in Montana (Flathead Co., *Holzinger & Blake 33,* US; Missoula Co., *Hitchcock 1662,* POM).

A collection from Guadalupe Island, Baja California (*Palmer 4217,* in 1875, K, MO, NY, UC) is difficult to assign to either species on the basis of the available material. No plants of either species have been collected on Guadalupe Island subsequently, and perhaps the plant is extinct there. For the present, we place this collection in *E. foliosum,* mainly on the basis of flower size. Additional material, if it were to become available, might cause us to alter this determination.

Epilobium minutum Lindl. ex Lehm., in Hook., Fl. Bor.-Am. 1:207. 1833.—*Crossostigma lindleyi* Spach, Nouv. Ann. Mus. Paris 4:404. 1835; based on *Epilobium minutum* Lindl. ex Lehm.—*Epilobium lindleyi* (Spach) Rydb., Fl. Rocky Mts. 586. 1917.—*Epilobium adscendens* Suksd., Deutsch. Bot. Monats. 18:87. 1900; illeg. subs. for *E. minutum* Lindl. ex Hook.—Lectotype: Washington, Skamania Co., abundant on a mountain near Stevenson, 3–5 Sep 1825, *David Douglas* (Hololectotype: K, isotype: NY; selected by Munz, N. Amer. Fl. II. 5:208. 1965).

Epilobium minutum var. *canescens* Suksd., Deutsch. Bot. Monats. 18:87. 1900. Type: Washington, Klickitat Co., Falcon Valley, 27 June 1892, *N. Suksdorf* (WS).

Annual, simple or diffusely branched, (3–)5–25(40) cm tall, suberect; leaves mostly alternate, narrowly elliptic, entire or remotely and obscurely denticulate, 1–2(–2.5) cm long, the lowest ones opposite, lanceolate or oblanceolate; buds broadly ovoid, not crowded, often nodding individually; petals (1.5–)2–4(–5) mm long; stigma 4-lobed or entire; seeds obovoid, smooth, 0.86–1.20 mm long, the coma easily deciduous; gametic chromosome number, $n = 13$.

Chromosome count vouchers, all $n = 13$: U.S. California. Butte Co.: Magalia, seeds from *Howell 37457,* CAS, grown at Stanford Univ., *Raven 19088* (MO). Del Norte Co.: Patrick Ck., *Raven 18380* (MO); 7.6 mi NE of Crescent City along Hwy. 199, seeds from *Breedlove 3087* (MO), grown at Stanford Univ., *Raven 19761* (MO). Lake Co.: 0.2 mi E of Lakeport on road to Hopland, *Raven 18236* (MO); 5.9 mi E of Houghs Springs, *Raven 18402* (MO). San Benito Co.: 5.4 mi from Hernandez on road to New Idria, *Raven 10585* (MO). San Mateo Co.: Jasper Ridge, Stanford Univ., *Raven 18258* (MO). Santa Barbara Co.: road from Davey Brown Public Camp to Sargent Cypress Forest, seeds from *Hardham 3381* (CAS), *Raven 18774* (MO). Santa Clara Co.: near Red Mt., on J17, *Seavey 1090* (MO). Sonoma Co.: intersection of Joy and Bittner Roads, SW of Occidental, *Seavey 1092* (MO). Stanislaus Co.: Arroyo del Puerto, 6 mi E of Junction in San Antonio Valley, *Raven 18229* (MO). Trinity Co.: 6.3 mi S of Trinity Center on road to Minerville, *Raven & Snow 13571* (RSA; Kurabayashi et al., 1962). Oregon. Douglas Co.: bluffs of the Umpqua, opposite Roseburg, *Raven 18383* (MO). Washington. Kittitas Co.: DeRoux Forest Camp, upper N Fork of Teanaway R., seeds from Kruckeberg, *Raven 18990* (MO); Denny Moore Forest upper Cle Elum R., seeds from Kruckeberg, *Raven 18991* (MO).

Canada. British Columbia: Queen Charlotte Islands (Taylor and Mulligan, 1968, p. 92; three localities). South Pender I., near Victoria, seeds from *Calder 29886* (DAO, MO). Lillouet Dist., above Piebiter Ck., Bralorne, seeds from *Kruckeberg 5733* (WTU), *Raven 19090* (MO); N end of Butte L., Vancouver Is., seeds from *Calder 30566* (DAO).

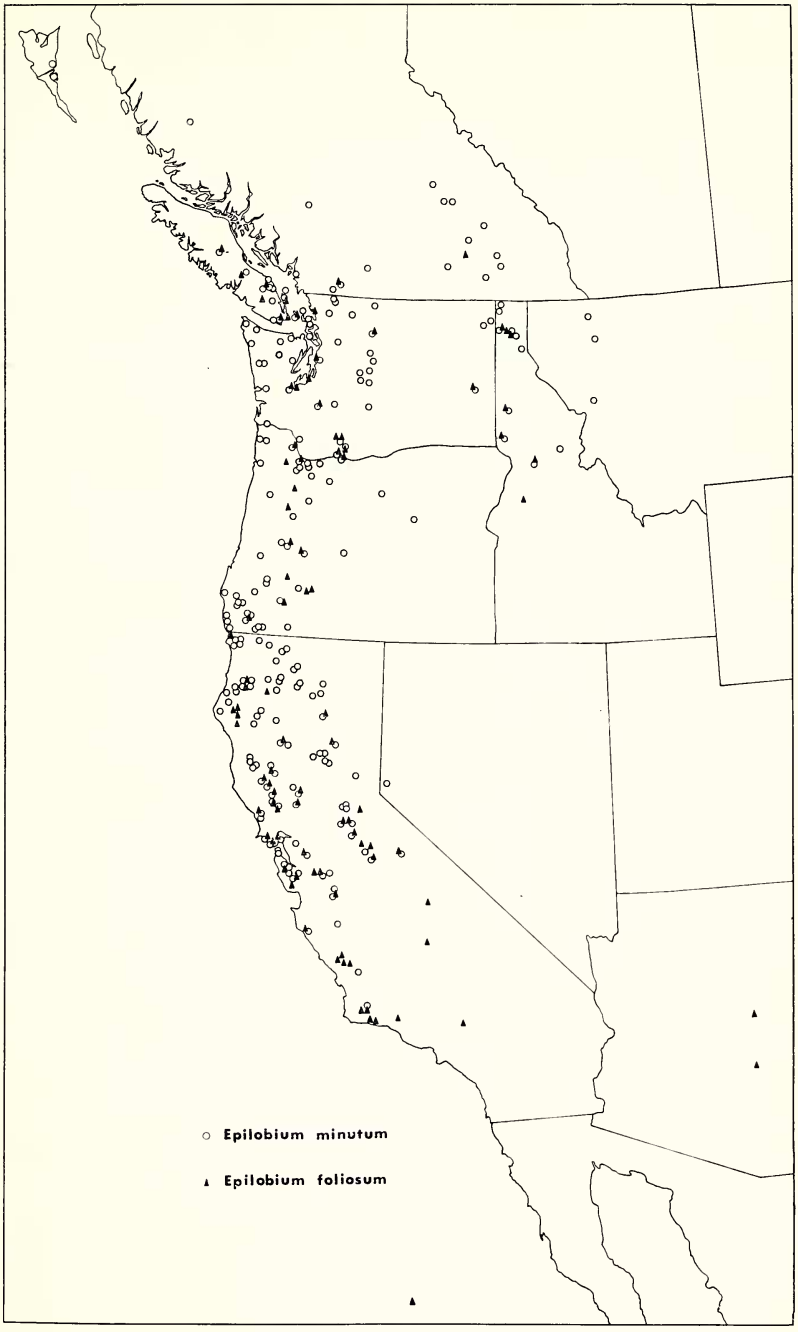

FIG. 3. Ranges of *Epilobium minutum* and *E. foliosum*.

Epilobium foliosum (T. & G.) Suksd., Deutsch. Bot. Monats. 18:87. 1900.—*Epilobium minutum* var. *foliosum* T. & G., Fl. N. Am. 1:490. 1840. Type: Dry rocks, Oregon and the Rocky Mountains of California, 1834–5, *Thomas Nuttall* (Holotype: NY; isotopes: BM, K).

Epilobium minutum var. *biolettii* Greene, Pittonia 2:296. 1892. Type: California, Marin Co., Sequoia Canyon above Mill Valley, Mt. Tamalpais, May 1892, *Bioletti* (Holotype: UC).

Epilobium foliosum var. *glabrum* (T. & G.) Suksd., Deutsch. Bot. Monats. 18:87. 1900. Type: Washington, Klickitat Co., moist, stony places, rare, on western plains, 17 May 1892, *N. Suksdorf 2108* (Holotype: WS; isotypes: NY, UC, US).

Like *E. minutum,* but leaves more pointed, very narrowly elliptic, the lowest ones narrowly lanceolate, often folded along midrib; axillary fascicles more frequent; flowers smaller, often cleistogamous, pointed in bud, usually crowded, erect; petals 1–2(–2.5) mm long; seeds slightly papillose, 0.64–0.85 mm long. Gametic chromosome number, $n = 16$.

Chromosome count vouchers, all $n = 16$. U.S. California. Fresno Co.: Simpson Meadow, Middle Fork Kings R. (seeds from *Howell 33792,* CAS), *Raven 19083* (MO). Mariposa Co.: 3.7 mi NW of Coulterville, along Hwy. 49, *Raven 18348* (MO). Monterey Co.: Twin Valley, El Piojo (seeds from *Hardham 5650,* RSA), *Raven 17528* (MO). Tuolumne Co.: ridge above Twain Harte (seeds from *Lewis & Snow 1243,* LA), *Raven 16025* (MO). Ventura Co.: Rose L. (seeds from *Hardham 6126,* RSA), *Raven 17741* (MO). Idaho. Valley Co.: E side of Big Payette L., *Raven 18518* (MO). Oregon. Douglas Co.: 20 mi E of Roseburg (seeds from *Gratkowski,* OSC), *Raven 19089* (MO).

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